PSYCHE.

ON THE NUMBER OF MOLTS OF BUTTERFLIES, WITH SOME HISTORY OF THE MOTH *CALLOSAMIA PROMETHEA*.

BY WILLIAM H: EDWARDS, COALBURGH, W. VA.

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Mr. Lintner, of Albany, N. Y. (Entom. Contributions, III, p. 129), speaks of four molts, though he does not say he saw the fourth. He speaks of first, second and third, and adds, "the subsequent moulting was not noticed," evidently considering that a fourth should take place, and probably he was aware that it had done so from the difference in markings between the larval stages.

Mr. Lintner states that the eggs were laid 17 June, and hatched in 19 days, 6 July. The second molt was passed 20 July; third molt 1 Aug. On 9 Aug., "some of the colony commenced the construction of their cocoons, 52 days from oviposition and 33 days from the disclosure of the larvae."

The larvae at Coalburgh, passing but three molts, had therefore but four stages. Stages 1 and 2 were essentially alike, the coloration being yellow with black stripes across the segments. At the second molt a radical change in coloration took place, and this stage, the third, and the following (or last) were in this respect essentially alike. The color was now, at second molt, whitish with a green tint; the black stripes had entirely disappeared and on each of segments 3 and 4 (head being segment 1) were two dorsal appendages much larger than other dorsals, cylindrical, high, light yellow, *with concolored spurs around the rounded summit*, and a black ring at base; on segment 11 was a single similar process on the medio-dorsal line. As the larva approaches the third molt, and about 24 hours before the same, the *four anterior processes gradually change color, turning first ochraceous, then dull orange, and so continue to the molt.*

After the third molt, or at the fourth and last stage, these processes have changed, *all having lost their crowns of spurs*, and become oval topped; those on segments 3 and 4 are red, and look like sealing wax, but the one in segment 11 retains its yellow color.

It will be seen therefore that (apart from several other differences which I might have specified) the *first two stages are black striped but the last two have no stripes*, and of these last two, the first has five yellow, *crowned knobs* or processes on dorsum, while in the last stage the *knobs have lost their crowns*, and four of them are red, one yellow. So that

it is easy to distinguish apart the third and fourth stages, and indeed it is not possible to mistake one for the other.

I had bred these larvae in glasses and watched them several times every day. The moment I noticed a swelling on the second segment, which always precedes and advertises a molt in lepidopterous larvae, I separated the swollen larva and followed it carefully. I also preserved the casts of the face at each molt, and examples of the larvae in alcohol both at the beginning and end of each stage.

I looked further at Prof. Riley's description of the same moth (Fourth Missouri Report, p. 121). Mr. Riley gives four molts for this species, and says: "The first stage is yellow, with two transverse dark bands" (to each body segment). "In the second stage there is no essential change," etc. So far Prof. Riley and I agree in all points. He goes on: "In the third stage *the transverse stripes are more conspicuous*." Here we part, and this stage did not discover itself in my observations. "In the fourth stage (or after the third molt) . . . the *body is still paler* . . . the transverse *stripes are broader*," etc. This stage also is in addition to any observed by me. In the fifth stage (or after the fourth molt) the appearance is totally changed, the body is of the most delicate bluish-white . . . the four dorsals on segments 2 and 3" (my 3 and 4) "are at first yellow, with a black basal annulation, but they soon become red, that of joint 11" (my 12) "remains yellow," etc. Nothing is said of the crowns of spines on the dorsal processes, which I found a conspicuous feature at the stage after the second molt, or of a molt intervening between the processes being yellow and their being red (for the change in the processes which precedes the last molt is *not to red*, but *to ochraceous and then orange and no farther*). It is evident then that Mr. Riley's fifth stage is equal to my third and fourth together, and that his third and fourth stages did not appear at all in my larvae. Certainly the larvae at Albany behave differently from those in Missouri, and both differ materially from those at Coalburgh. It has occurred to me that Prof. Riley's observations might have been made on larvae of *C. angulifera*, a form which he says he regards as a variety of *C. promethea*, but which I formerly bred, and then had no doubt of its distinctness from *promethea*. The periods of my brood of larvae were thus:—

Eggs laid 19 April.			
Eggs hatched 1 May.	Time	11	days.
Larva, 1st molt 7 May.	"	6	"
" 2nd " 11 "	"	4	"
" 3rd " 15 "	"	4	"
In cocoon 22 May.	"	7	"

Three ♂♂ moths issued 16 June. Time 25 days. Others at intervals for a month later.

Whole larval period 22 days.

From egg to imago, 58 days.

After correspondence with Mr. Lintner on the discrepancy of our observations, in which he thought I must have missed a molt, I bred a second lot of larvae from eggs laid by a female which emerged from the first lot of cocoons, on 20 June.

I found it paired in the box, and it laid 162 eggs, 21 June.

Eggs laid 21 June.
Eggs hatched 1 July. Time 10 days.
Larva, 1st molt 4 July. " 3 "
" 2nd " 9 " " 5 "
" 3rd " 13 " " 4 "
In cocoon 18 " " 5 "
First moths issued 12 Aug. Time 25 days.

Whole larval period, 18 days.
From egg to imago, 52 days.

The behavior of the pupae of this brood was in this way. On 12 Aug., 2 ♂ emerged. As I desired to keep examples of the moth of each brood for comparison, I killed these, expecting to see plenty more. On 13 Aug. 3 ♀ emerged; on 14, 1 ♀; on 15, 2 ♀; on 16, 1 ♀; on 17, 1 ♀; and no more of either sex appeared. So I lost the opportunity of mating any females in the boxes. I tied all these ♀ ♀ out at night and kept them out several nights, bringing them to the house during daylight, until all of them were broken up, but in no case did a male visit them. That means that at this period no wild males were flying in the vicinity. Had I kept the males which issued 12 Aug., another brood would have been raised, making the third in succession. As it was, the females tied out laid many unimpregnated eggs on the trees to which I confined them. Another ♀ emerging from the first lot of cocoons on 16 July gave me another opportunity of verifying my observations.

Eggs laid 17 July.
Eggs hatched 27 July. Time 10 days.
Larva, 1st molt, 1 Aug. " 4 "
Larva, 2nd molt, 6 Aug. Time 5 days.
" 3rd " 11 " " 5 "
In cocoon 18 " " 7 "
Whole larval period 22 days.

No moths issued from this lot, but all the cocoons are wintering. About two-thirds of the cocoons from the eggs laid 21 June gave imagos, and about one-third are wintering. But both these last broods, as I have said before, came from the first lot of cocoons.

I was careful at all points in these two broods, the more so as my attention had been directed to the different results between my observations and others recorded. The rapidity of the changes in both broods, caused by the hot weather, no doubt, will be noticed, in one brood but 3 to 5 days intervening between any of the molts, in the other from 4 to 5. In the last stage of the second brood the time was 7 (from third molt to cocoon). In this last brood it happened that I painted red a part of the last segment of every larva just after the third molt. These red marks were not lost, but stuck to the larvae till they disappeared in their cocoons. I do not remember ever reading of this device for identifying larvae, but with light colored and smooth-skinned ones, it answers admirably.

So I am thoroughly satisfied that *C. prometheus*, at Coalburgh, passes but three molts, and it becomes very probable that this species at least varies in the number of molts with the latitude or locality. At Albany, N.Y., I suppose there is but one annual brood. Mr. Lintner found the period from the laying

of eggs to cocoons, mostly in midsummer, to be 52 days. At Coalburgh, the broods ran from 33 days in April and May to 28 days in June and July. The larval period only at Albany was 33 days, at Coalburgh 22 and 18 days. Perhaps in attaining to a double or triple annual generation, the species has come to have its larval stages diminished by one, and in W. Va. molts three times while at Albany it molts four times.

Mr. Trouvelot (Amer. Nat., v. 1, p. 37) has recorded his observations on the allied silk-worm moth *Telea polyphemus*, and says; "The *polyphemus* worm, *like all other silk worms, changes its skin five times during its larval life.*"

In the Entomologist, London, 1879, v. 12, p. 26 et seq., Mr. P. H. Gosse details at great length the larval history of *Attacus atlas* from farther Asia, bred by him from eggs obtained from the female which had emerged from cocoon in Europe. He describes in full five molts.

The only other large moth whose larval stages I have carefully watched is *Dryocampa imperialis*, which has four molts only.

EFFECT OF COLD APPLIED TO CHRYSALIDS OF *LIMENITIS DISIPPUS*.

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I succeeded in bringing two larvae through the last winter. No. 1 pupated at 3 P. M., 22 April. At 9 P. M., same day, I placed the chrysalis in an ice box, where it remained till 9 P. M., 6 May, 14 days. No. 2 pupated at 7 P. M., 27 April, and at 7 A. M., next day, the chrysalis was put on ice and remained till 7 A. M., 7 May, 10 days. Temperature, 40° F. [4° C.]. (In 1880, I subjected two chrysalids of this species to a temperature of 32° F. [0° C.], and killed both.)

On 13 May, two butterflies emerged: from No. 1, a ♂; the other ♀. Both are alike in color above and below; above dark, resembling southern *Danais archippus*. In the ♂, the black mesial band on hind wings is wider than usual, though I have one example, bred at Coalburgh, like it; but in the female, this band is extraordinary, nearly three times as wide as usual, measuring 2.5 mm. at the cell. Beneath, in both, the whole hind wing is very light, a fawn-color, with no fulvous tint, quite unlike any Coalburgh or western or southern example, though resembling Catskill examples, except that these have a tint of fulvous.

As appears, the change is most decided in the female, though this was exposed when 12 hours old and for 10 days only, against 14 days in the male, at 6 hours old.

I had hoped to see the butterflies much melanized, and so approaching *Limenitis proserpina*, from which it has been conjectured *disippus* is derived. But nothing has occurred in support of that view.